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1618

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1827

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1618

THE MANNER
Of Securing all Sorts of BUILDINGS from Fire.

OR

A TREATISE

UPON THE

CONSTRUCTION OF ARCHES

made with BRICKS and PLAISTER, called

FLAT-ARCHES,

And of a ROOF without TIMBER called a

BRICKED-ROOF:

With the Addition of some LETTERS that have passed between the Count of ESPIE and PETER WYCHE Esq; on this Subject.

Adorned with two COPPER-PLATES serving to illustrate the whole Work.

Written in French

by Monsieur le COMTE D'ESPIE,

Knight of the Military Order of St. Lewis,

And Translated

by L. DUTENS.

LONDON:

Printed for and sold by H. PIERS and Partner, near the *Bull* and *Gate High-Holborn*, and to be had of *T. Payne* at the *Mews-Gate*, and M. COOPER at the *Globe* in *Pater-Noster-Row*.

TO
William Beckford Esqr.

SIR,

THE Approbation you have given to this Work, and the Readineſs with which you came into the Author's Scheme are the Motives which have induced me to make a Tranſlation of it, and now with Permiſſion take the Liberty of preſenting it to you in the Form you ſee it. The Zeal you have always ſhewn for promoting the Publick Good and encouraging Arts tending to that End has been in many Inſtances conſpicuous to all: but in this particular of introducing a Method of ſecuring Publick as well as private Edifices from Fire, you appear not only as a Friend of their Properties but alſo of their Lives. It is by the Example of Great Men that a Common-Wealth flouriſhes in Riches and in Arts, and how are they ſufficiently to be praiſed who promote thoſe Inventions that ſecure in any Degree Mankind from the Danger of being loſt or deſtroyed? The Preſent Age will conſider the Merit of your Patronage and Poſterity will probably rejoice in the Fruit of it. I have the Honour to be with the utmoſt Reſpect,

SIR,

Your moſt humble
and obedient Servant,
L. DUTENS.

PREFACE

Of the AUTHOR to the

Duke of BELLEISLE.

MYLORD DUKE,

A Treatise on the Constructing a Roof in a form absolutely new, may perhaps seem unworthy and below the Dignity of your Protection; and the liberty I take to offer it you may by some be thought blameable; but here in I shall think myself justified, if your Grace condescends to accept of it, and I flatter myself with an Opinion of your approving it, because I think my Discovery usefull, and that great Men value things more from their Utility than from their Appearance. I do not offer you this as a Composition fit to be dedicated to a famous General, or to an able Politician; but in this I consider your Grace's Character, as the best of Patriots whose penetrating Zeal takes in all that can contribute to the Public Welfare, and who by many excellent Experiments has demonstrated the great Concern you have for the good of Mankind, and the Value you set on such Improvements as tend to the Advancement of all Arts and Sciences. How much the World stands

indebted

indebted to you, Mylord Duke, the City of Mets is a signal Instance. The Fortifications now built with the Improvements formed and conducted by your Skill and Management, is such an Instance of your Abilities that they will for ever stand the Surest and best Test of the fine Taste and the vast Genius natural and inherent in you. It has been by your excellent Judgement that this Place is now made the strongest in Europe, and rendered formidable for ever to all the Enemies of France. I shall forbear mentioning that noble Defence you made of Marseilles and of your famous Retreat whereby the Glory of the Action redounded as much to your Honour as if you had obtained the greatest of Victories. The care of those memorable Things I purposely leave to others whose Province it is to transmit those great Exploits to future Ages in a more able Manner than I can do. They would improperly be placed in the Work I now present you with: this Treatise is intended to be of another Nature; it is to give you a Description of a new invented Roof which I call a Bricked-Roof, *and as the Invention has so great a Resemblance to the flat Arches you have introduced in these Parts, this Fact alone determined me to take the Liberty I now do of dedicating this Treatise to you, and beg your Grace will receive it as a Proof of the profound Respect I have for you. I have the honour to be,*

MYLORD DUKE,

Your Grace's
most humble &c.

ADVERTISEMENT.

MAny with Reaſon object to new Diſcoveries and conſider them as mere projects, but when matters have been examined with Care, as I hope this of mine will be, there may ſomething be made appear, though new, yet not unworthy of Attention and what may tend to the Advantage of the Reader.

Some Years ago I withdrew from the Army, and being at full Leiſure I thought I could not employ myſelf better than to conſider how I might improve ſome things in the military Art, and by frequently reflecting that accidental Fires were the moſt deſtructive things to the beſt inventions of military Science, I began Solely to reſtrain myſelf to this thought of finding ſome Means or other whereby I might make Arſenals and Fortreſſes, as to their Building, abſolutely incombuſtible. I flatter myſelf that I have found it, and upon reviewing the ſeveral Tracts that have been wrote on this Subject, I have not ſeen one that gives the leaſt Idea of this Matter. To digeſt theſe Thoughts and to bring them in the ſhort Compaſs they appear in, I made

made many Experiments, and the Succeſs of them anſwered my Expectations in every Reſpect; I ſhould therefore think myſelf highly blameable, if I did not communicate ſo uſefull and important a Diſcovery to the full View of the Public in general.

The Invention is this; to erect a Roof of ſuch Conſtruction (which three Years ago I myſelf built on my Houſe at Thoulouſe) as to be abſolutely compoſed of no other Materials than Bricks, Mortar, and Plaiſter; there being no Wood or Iron in the whole Formation of it; and therefore I give it the Name of a *Bricked-Roof.* This Roof is ſupported by flat-Arches and is of a Wonderfull and particular Texture as to its Work, ſome may deſcry it, becauſe they know not the Uſe of it, and becauſe it at preſent appears new, but it is a Method of Building in Rouſſillon very old and of great Antiquity, and tho' known there for ſome Centuries paſt, yet has this Method but lately been brought into the adjacent Provinces in France, and about Thoulouſe in Languedoc. The Duke of *Belle-iſle* gave the firſt Idea of theſe Arches in this Country. He ſent for Workmen from Perpignan to build him theſe Kind of Arches in his

Houſe at Biſſy, theſe Men being more ſkilfull in this Method than Artiſts from any where elſe.

There was likewiſe an Architect of Avignon who in *April* 1750 publiſhed in the French Mercury ſome thing about theſe flat-Arches and prepoſterouſly ſaid he was the Inventor of them. It was publiſhed likewiſe the Month following in the ſame Journal by Mr. de la *Cheze* Engineer of Thionville in a Letter from him to Mr. le Marquis *de Rougé* Field-Marſhall of the Armies of France, and by Mr. *de la Sauvagere* firſt Engineer of Port-Louïs; this laſt Letter is more inſtructive than the former, but neither the one or the other ſeems ſufficient for the Reader's Improvement; therefore I thought I might venture to give a more Circumſtantial Account of theſe Arches, ſhew their Advantages and point out the Manner how they are to be built, there are Copper-Plates at the end of this Work by which the Reader will be able to Judge of the Plan of theſe flat-Arches and ſee the Inſides and Profils of them as well as of my Bricked-Roof.

Bricked - Roof.

TILL now there has been no other Way of covering Buildings but by Timber and Wood, except in the Powder Magazines, theſe indeed are built with Arches but greatly Loaded with thick Maſonry-Work that they may be Bomb-Proof.

As to the Magazines deſigned for the Proviſions of the Army, they as well as the Arſenals are all covered with wooden Roofs. Theſe Roofs can be no Fence againſt Fire, becauſe it may be communicated to them by Lightning or by the Flames of a contiguous Building or in time of War by Red-hot Canon-Balls.

Whereas theſe new Roofs are free from all theſe Defects and Inconveniencies, and beſides have ſo many other Advantages that no Body will ſcruple to give them the Preference when their Conſtruction is examined and fully underſtood. I ſhall more fully deſcribe theſe flat-Arches when I give you the Account of thoſe whereon the Bricked-Roofs are to be built.

Flat-Arches.

THERE are few in France that have not heard of Arches made of Bricks and Plaiſter, becauſe ſome time ago it was the prevailing Faſhion in ſeveral Provinces of this kingdom, their Solidity will always be the cauſe of their being preferred to any others, becauſe thereon the Floors may be made more advantageouſly, at leſs Expence, and have none of the Inconveniences that a Wooden-Floor has. Without reckoning the Riſk you run of being cheated by the Timber-Merchants.

In Rouſſillon and Languedoc they uſed theſe flat-Arches only in their Churches; and for out-Buildings, ſuch as Coach-Houſes, Barns, Stables and Granaries, that they might be well ſecured from the Accident of Fire. I am the firſt who has attempted to introduce them in Gentlemen's Houſes; having built mine own at Thouloufe in this Faſhion: and the Form of them is ſo agreeable to the Eye that all who ſee them, (though they ſeem outwardly like all other Cielings in common uſe) yet for their Solidity and their Advantage in not being liable to be fired, Gentlemen of this City as well as others in this Neighbourhood have followed my Example and are pleaſed with the Effect.

It

It is much to be wiſhed they were univerſally introduced throughout the Kingdom, what a Number of Lives as well as Houſes would be preſerved from Fire? Accidents that are now ſo frequent and ſo numerous would in a great meaſure be avoided, and beſides this great Security there are other Advantages peculiar to theſe ſolid flat-Arches and ought to be well weighed; for Inſtance they make Appartments in Winter warm and in Summer cool, Rats and Mice can find no ſhelter there, neither is Noiſe any ways communicated from an upper to a lower Floor, which as the form now is, is very troubleſome, notwithſtanding the Care taken to fill up Vacancies and making our Floors double, a Method very expenſive and what is more takes up a great deal of Room: neither does it abſolutely prevent the Inconvenience, for an hollow diſagreable Sound is always perceptible, and beſides the incloſed Timber of the Floor (as it lies out of Sight) in time grows rotten, no Repair therefore can be done, at laſt it falls and the whole muſt be rebuilt.

We call theſe *Flat-Arches* becauſe they in their Riſe have leſs Elevation, if you would chuſe it, than thoſe generally uſed, and becauſe in about two thirds of their Elevation the Bricks herein are laid flat, whereas in the common Arches they are laid always obliquely on their narrow Side.

The

The Bricks uſed at Perpignan for theſe Arches, and what I myſelf uſed, are in Length ten Inches, in Breadth five and in thickneſs one Inch; this Size is more agreable to the Form of the Arch and joins much better than the larger ſort of Bricks made in Convents and other Places, before this Conſtruction of mine appeared. It is evident at firſt View that a ſmall Brick of five Inches Breadth only will better ſuit with the Curvature of an Arch than one of ten Inches Breadth and further their Surface is more in proportion than that of the great ones, and conſequently may be more loaded with Plaiſter in a duplicate Ratio of their Capacity, ſo that their Solidity will be much more firm than thoſe where the larger Brick is uſed. Great Caution ought to be taken as to the Bricks and Plaiſter, the Bricks ought to be perfectly well burnt and afterwards kept perfectly dry, not expoſed to Rain or any Wet; the Plaiſter ought to be uſed whilſt the Fire is in it immediately after it is burnt and never to be expoſed to the Air; for which Reaſon it would be right to make your Bricks and burn your Plaiſter on the Spot where you intend to build, for by theſe Means you will have the full force of each Material, and the ſooner you uſe them the better: as to the Plaiſter great care muſt be taken to ſlack it in ſmall Quantities, which ſmall Quantities muſt be immediately uſed in the Work and then ſlack more, and uſe it as quick as before directed, and ſo on till the Work be compleated.

Theſe

Theſe Arches may be built in any Form that is now in uſe, in a full Center, in an Elliptical Form, or in any other Form whatever.

Where openings are to be made you may make Windows or any Kind of Light in the Arch Work itſelf, and even Doors, and theſe may be placed higher than the Riſe of the Arch, but the beſt Form for Appartments is the Elliptical Curve, or an Arch like the Top of a Coach, the Sides of this Arch take up one half of the leſſer Side of the Room and muſt have the ſame Curvature as the Reſt of the Arch. For grand Appartments the Curve or Center ought to be a little more than a third of the Breadth of the Room, if you would have the Cieling lofty, as the Italian Manner is: of a fifth Part if Loftineſs be not required and of an eighth Part for the leaſt Elevation; for we are taught by Experience that Arches which have little Riſe cannot long ſupport themſelves, being built at firſt too flat.

As for the Centers to be uſed either for the Arch of a Coach-Top, or for any other Form you determine to have, they are to be made of ſuch Materials as are at hand, they are very light, and may be patched up with any refuſe Wood you uſe about the Houſe, for which Reaſon they cannot be expenſive; obſerve theſe Centers are not made to bear the Weight of the Arch, but merely to guide the Workman in his Direction as to the form he is to build in.

A new

A new built Wall muſt ſettle for ſix Months before you begin to Conſtruct your Arch; this is an eſſential Precaution and never to be neglected, for I have greatly found my Account in it. Upon old Walls likewiſe theſe Arches may be conſtructed, provided they be ſolid and the Brick-Work not damaged by Time. To make theſe Arches ſolid and to cauſe no Puſh againſt the Walls, a Space of three or four Inches is left in the Wall all round the Room from whence the Arch takes its Spring; ſo that the firſt Brick of the Arch is to ſtand on its long narrow Side on the Retreat of the Wall, almoſt perpendicular, forming an Angle of 80 Degrees. If the Walls be old but the Work good, the ſame Space or Niche is to be made round the Room as in new Walls for the purpoſe of laying the firſt Brick of the Arch before deſcribed.

Theſe Arches may be made either Single or Double, the ſingle ones are only for upper Parts of Buildings which are expoſed to the Air and carry no Weight, but it would be more judicious to make even theſe double by laying a ſecond Brick, covering the firſt and obſerve that the Joints of the ſecond are never to coincide with thoſe of the firſt.

The Manner in which the Workman conſtructs his Arch is as follows; after he has fixed well his Center, he ſtretches far above his Line from

from one Side of the Room to the other at the heighth of five Inches above the Space whence the Arch is to take its Riſe, but firſt cleans this Space or Niche of what Duſt or Filth is in it, then he Moiſtens this Niche and afterwards puts therein a little Plaiſter and lays upon it the firſt Brick, putting to each of the two Sides of the Brick ſome Plaiſter, that is ſome Plaiſter to the ſide of the Brick that lies on the Niche, and ſome to the other ſide of the Brick that goes to the Wall and is to cement with it; afterwards he fixes well the Bottom of the Brick upon the Direction of the Niche, that it may remain immoveable and not be taken in or out but lie level with it; he fixes the Top of the Brick according to the Direction of the Line; when he perceives the Brick is well ſet, he then leaves it and proceeds to lay the ſecond Brick; he puts a little Plaiſter on the Niche and to the ſides of the firſt Brick; then he manages the ſecond as he had done the firſt, *to viz.* by putting Plaiſter on that ſide of it that is to lie on the Niche, on the other ſide of it where it is to join with the firſt Brick. He thus proceeds in the Work till the four Sides of the Room be finiſhed. It muſt be obſerved the Workman never lays a Brick till it be firſt dipped in Water, for this makes the Plaiſter inſinuate better into the Pores of the Brick and renders the Work more ſolid. After the Workman has laid the firſt Range of Bricks quite round the Room, for we ſuppoſe that the Arch

now

now building to be of the form of the Top of a Coach, he then proceeds to make his ſecond Operation : he now changes his Line and elevates it five Inches more on high and lays the firſt Brick of the 2d Range, by putting ſome Plaiſter to two of its Sides as he did before to the Brick of the firſt Range which muſt be joined and cemented with it. This 2d Range muſt be formed on the Top of the firſt, following the Direction of the Center and of the Line till ſuch Time as it be finiſhed quite Round the Room. The Workman takes great Care that the firſt Brick of the 2d Range is but half the Length of that uſed in the firſt Range, that the joints of the 2d Range interfere not with thoſe of the firſt ; this he muſt obſerve throughout the Work to make it more firm and ſolid.

The ſecond Range of Bricks being now laid all round the Room, the Workman proceeds to the 3d Operation, which is to Double the Arch with a 2d Brick in covering it upon the firſt. Which is very eaſily done by putting a Coat of Plaiſter on that Side of the Brick which reſts on the Firſt with the ſame Caution as above mentioned not to ſuffer the Joints of the 2d bed of Bricks to interfere or mix with the Joints of the firſt in any Place whatever.

The Workman uſes theſe following Tools or Utenſils ; a Trough in which he ſlaks his Plaiſter

Plaiſter to the Quantity he wants; a Trowel ſome what longer and wider than thoſe of the Maſons to beat up and lay the Plaiſter on his Bricks: an Axe-hammer, to break Bricks with the Edge of it when neceſſary, and with the other End to give ſlight Blows to the Brick he lays, that the Plaiſter on which it ſtands as well as the Plaiſter on which the other Bricks are joined with, may all be compreſſed ſpeedily and the Work ſet well and tight together. The Hammer ſerves not only to faſten the Bricks but to direct the Courſe of them conſiſtent with the Line, and ſuffers them not to deviate from it.

When the Plaiſter is good and has its full Fire in it, it ſets very readily; as ſoon as the Workman has done the Sides of the Arch, and begins to lay his Bricks flat, he then ſtrikes it with his Hammer and holds it up with his Finger, and when he perceives it is firm and has ſet properly, he then leaves it and proceeds; all which is done in the Space of twenty Seconds.

The Workman takes great Care never to lay a new Range of Brick till he has performed the firſt Range all round the four Sides of the Room; and this he does that the four Sides may all equally riſe towards the Center of the Arch, till all meet in one Aperture, to be cloſed by one ſingle Brick: I have ſeen theſe Workmen make an Arch in the Form of a Trapezium, and they

conducted all the four Sides of it so equally and with so great Truth, that the Aperture about the Center of the Arch formed an exact little Trapezium to be filled up with a last Brick of that Form. This exact Uniformity of Ranges is always practised by the best Workmen, because the Work hereby is made much better.

The Remaining small space between the Wall and Curvature of the Arch is filled up with Plaister and small bits of Bricks called Ribbles to the heigth of ten Inches or a Foot, then they construct little Buttresses from the Walls to the Sides of the Arch; these Buttresses are placed at the Distance of four or five Feet one from another, and they observe chiefly to bring them from each of the four Corners of the Arch, they being to be considered as the most essential Points when the Arch is to be built in the form of Coach-Top, or *en Imperiale.*

These Buttresses are made by Bricks made Flat, and they are in Dimension five Inches wide, two Inches thick, and fifteen in length, called Tiles *en Barreau.* They should lose themselves insensibly at the third Part at least of each side of the Arch, and they should, if you please, be some Inches below the Center of the Convex Crust of the Arch; again these Buttresses are made with large Bricks which in length are 15 Inches, ten Inches wide, and two Inches thick, commonly

commonly called Plain Tiles; they lay them obliquely two by two, by joining them with Plaiſter and raiſing them to the ſame Heigth before mentioned; theſe Buttreſſes ſo built likewiſe ſerve to keep in and contain the Arch. The ſpace between the one and the other Buttreſs muſt alſo be built with Brick and Plaiſter to the ſame Heigth *viz.* to ten Inches or a foot; but in this Work no Mortar is to be uſed, becauſe of its Moiſture, a thing that will prevent the Cruſt of the Arch from ſetting and conſequently ſpoil the whole Work. They then finiſh the Arch by filling up the remaining Part with Earth well dried, or rather with Rubbiſh. Then the Floor is paved in what Form you pleaſe; as ſoon as the Arch is built, you may take away the Center without Scruple, for there is no Fear of its falling. The Centers, as I have ſaid before, being only a Guide to the Workman merely as to the Form or Figure in which the Arch is to be built.

The Inſide or Concave Part of theſe Arches muſt be ſpread with Plaiſter, and the Angles ſmoothed over and made to diſappear by it. A Corniſh ought to be made all round the bottom part of the Arch, above the firſt or ſecond range of Bricks where the Arch ſprings from. The Arch, to appearance, will then look as almoſt flat, and one would think it a Cieling of the beſt and handſomeſt Form: theſe Arches are capable of the richeſt Decorations you would chuſe to have.

When Time and Experience has evidenced the Solidity and Advantage of these flat-Arches, I am fully perſuaded that the Floors now in uſe, will be laid aſide and grow out of Faſhion, as ſubject to many Inconveniences, and in their Room theſe ſort of Arches will prevail not only in Houſes of private Gentlemen, but even in Churches and in all large Buildings whatever, as Convents &c. How often is it that Accidents of Fire happen here, and what Ravage and Deſtruction is made by it? and beſides the enſuing Charge of rebuilding is ſo great that the Religious Order muſt take a great length of time to reinſtate what the Flames have devoured. How many Houſes and whole Cities in Germany would have been ſecured from theſe Accidents of Fire, had they been built originally in this Form? we ſhould not then have ſeen ſo many dreadful Effects of it, as now appears in almoſt every Gazette.

There are Countries where theſe Arches may be built at a third leſs Coſt than the common Floors in uſe, and there are other Countries where they may be built for one half of the Charge; but more eſpecially are they moſt proper for thoſe Countries where Wood is rare. We are not to build theſe Arches under Ground nor in any place where the Moiſture of the Earth can affect it; for Moiſture of this ſort will abſolutely deſtroy the Arch, as being contrary to the Nature of Plaiſter.

In Countries where Bricks are very dear, and Iron very cheap, to leſſen the Expence of the Brick Buttreſſes, you may guard the Arch with Bars of Iron put at their proper Diſtance the one from the other and fill up the intermediate Space with Rubbiſh: thus have they done in Vivarais; but in Countries where no Brick can be had but where there is plenty of Stone, you are then to cut the Stone in the ſame Form with the Bricks before deſcribed, as to its Size in every reſpect. The Plaiſter will unite with the Stone, provided you leave the Coat of the Stone rough and a little irregular. But as it often happens that Moiſture is contained in the pores of the Stones, and ſhivers it in pieces when a hard Froſt comes; the beſt Way to ſecure the Arch from an Accident of this ſort is to dry your little Stones in the Sun or in Ovens till you are ſure the Moiſture is out, and that it is impoſſible for Froſt to have any ſuch Effects upon it. However, the Arch being coated below as well as covered above, and the whole contained in the Plaiſter, one would not think it natural that the Froſt would have ſuch an Effect upon it.

If the Room you have built is too large, and to be thought neceſſary to make a Diviſion in it, *viz.* an Alcove for a Bed, a Ward-Robe, or for Cabinets; all this may be done in Brick-work on the Arch itſelf without ſcruple or fear at all, provided always that the partition Walls have their

Foundation on the Brick round the ſides of the Arch on the ſolid part of it and not fixed on that which was filled up with Rubbiſh. If there be a Floor highly built and you have a Mind to make an intermediate Appartment between the firſt Floor and the ſecond which is called in French *Entre-Sole* with a Gallery to communicate with it from the Stairs, this likewiſe may be done without Inconvenience. I have done this in the Wings of my Kitchen and in all the Offices of my Building taking Care to obſerve the Rules before deſcribed.

A Comparison

OF

COMMON ARCHES, *with the* FLAT-ARCHES.

COMMON Arches, whether made of Stone or Brick, and laid obliquely with Mortar compoſed of Lime and Sand, require Attention, and the Workman in building them right, muſt follow certain Principles and Rules of Art from which he muſt never deviate.

The chief Care therefore of an Architect in the Conſtruction of ſuch an Arch is to make the Walls of a convenient Thickneſs, that they may reſiſt the Puſh of the Arch and the whole ſtand in its proper Equilibrium, otherwiſe if the Walls or the Stone on which it ſprings ſhould be too weak to withſtand the Puſh, the Arch will give from about the Middle of its Sides to the Key-Stone, becauſe it is in that Part where the Puſh of the Arch is greateſt, and of Courſe the thicker an Arch is, the greater will the puſh be, becauſe the Curvature of the Arch becoming longer and

of courſe heavier, it muſt neceſſarily act with more force and a greater Weight againſt the Butment, or upon the Stone from whence it takes its ſpring.

If the Pillars that ſupport the Arch be very high then muſt they he conſiderably thicker, that they may more effectually withſtand the Puſh of the Arch ; thus then it is that the thickneſs of the Pillars muſt depend on the thickneſs of the Arch, and be agreeable to its height be it more or leſs, ſo that the proportion of its thickneſs is always relative to the Weight and Puſh of the Arch.

Again it muſt be obſerved that different Arches require different Butments, for it is demonſtrated that Elliptical Arches have a much greater Puſh than the Semi-circular Arches, and that the Gothick Arches have much leſs and ſo on ; conſequently we ought to regulate theſe Proportions by following the Nature and Form of the Curve and conſidering what ought to be the greateſt and what the leaſt Elevation, and what thickneſs it ought to have, and therein act agreeable to ſuch principles as Art and Science require in theſe Matters.

Mr. *Belidor* in his Book of Inſtructions to Engineers has demonſtrated theſe Principles Geometrically, it is to be wiſhed that they who build would make themſelves acquainted with them

and

and not always follow the Road of Practice, for the Maxims of Practice are always falſe when not founded on the Rules of Theory. Hence it is that we often ſee Buildings unfiniſhed, fall of themſelves, occaſioned by not regarding thoſe Principles, that Science and the nature of the Work require in their different Forms and Dimenſions.

Flat-Arches being of a Conſtruction quite different; we have no Occaſion in the building to follow the Rules and Principles of the preceeding ones; in theſe it is quite unneceſſary to dwell on the thickneſs of the Walls, and provided they be ſound and well built it is ſufficient; for I am not of the ſame Opinion with thoſe who think that theſe kind of Arches puſh as the others do: Experience has fully demonſtrated the contrary, and the Inſtances I am going to produce may perhaps undeceive thoſe who are prejudiced with this Notion.

Knowing that the firſt Invention of theſe Arches was at Perpignan, and that it was from this Place that Mr. Marſhal *Belleiſle* had Workmen to build the flat-Arches he had occaſion for, I thought it worth my While to make a Journey there and ſee what had been done in this manner formerly. I there met with Mr. *Robert* the commander of the Caſtle, my old Friend and Acquaintance, who immediately ordered the Workmen

men Mr. *de Belleiſle* had employed, to come to me, and with them I conferred about theſe flat-Arches. They ſhewed me all the Works they had built of this Kind throughout the City, and a great number of theſe ſolid and well built Arches there are; but thoſe of the Jeſuits College pleaſed me the moſt, being built in ſuch a Form as makes the moſt beautifull Appearance; but though this Fact apparently exiſts, no body there has yet attempted the like for great Houſes as I have done at Thoulouſe. Afterwards I went to ſee the Convent of the Cordeliers and their Dormitory, which is built in the form of a Croſs, and contains more than ſixty Cells all arched with flat-Arches, built three or four hundred years ago by the Spaniards; the Walls of the Gallery are divided into Partitions, which have no Wood in them; in that Country theſe Partitions are called partitions of Brick laid in curved Forms, but double well joined and cemented with Plaiſter which gives to the Walls a thickneſs of ſomething more than four Inches; the Door-poſts of all the Cells are of free Stone of the ſame thickneſs of the Partitions and cemented with Plaiſter, to them they have contrived in the Stone a Rabbet to receive the Door with its Hinges. The Arch of the Dormitory is ſupported from one End to the other by theſe Partitions, it conſiſts of one Brick ſolely, and ſeemed to me to be a little Eliptical; the Cells are ſeparated one from the other by Partitions, and every Cell is divided again by another

Partition

Partition in two Rooms, which makes an Anti-chamber and a Bed-chamber, every Room is likewiſe vaulted with flat-Arches from the level of the Top of the Wall, and where the Curvature of the one Arch joins with its oppoſite they neceſſarily counter-act the one the other. In making a more minute Examination into all theſe things, I perceived the exterior Part of the Arch of the Dormitory was in many Places black, and dirty, but in others it appeared quite white as if newly done; I aſked what could be the reaſon of it, and they anſwered that the Roof had ſtood a long Time without having any Repairs done to it, and of courſe the Rain beating upon the Bricks, had formed many hollows and drove away the Plaiſter that cemented them, and that the Bricks being no longer ſupported, fell of themſelves: this was the reaſon of ſo many Holes appearing in it; but notwithſtanding, the ſtrength of the Arch was not weakened thereby. The reaſon why the Roof appeared with a Diverſity of Colours, is owing to the Repairs lately made, for they told me that they had juſt then filled up the decayed Parts with new Bricks and Plaiſter; and of this I was well aſſured by many of the Prieſts that belonged to the Convent. This Proof of the Solidity of the Arch is of itſelf I think ſufficient, but if this inſtance alone carries not with it that Conviction that others may require, I will mention ſome more.

A Gentle-

A Gentleman in Languedoc built one of these flat-Arches upon old Walls, some time after, one of the Sides of the Arch gave way and separated from the others, leaving a considerable Gap, insomuch that all that Side was expos'd to the Heavens, and the remainder of the Arch was supported only by the three Sides of the Wall; they sent immediately for Workmen to rebuild and restore the Wall, upon their inspecting it they durst not meddle with it, fearing they should be crushed by the remaining Arch, which they thought would fall upon them every moment, but on the next Day when they saw the Arch still standing and that it was not likely to fall, they took Courage, ventured to remove the old Wall, rebuild it properly and united the Arch as it was before.

Another Gentleman of credit whom I am acquainted with, told me, he had made the following Experiment, to try the solidity of these Arches before he ventured to use them in real Work. He made a Frame of Wood in a square Form, each side of which was in thickness and width about five Inches, and in length something more than six Foot: these four Sides were joined to each other at their ends, and well screwed together at the Angles in the strongest Manner possible, and put in a Room that was paved to be out of the way of troublesome People. He then considered the four sides of the Frame

as

as ſo many Buttreſſes, and covered the interiour Space of it with a little flat-Arch of ſix Foot ſquare, and in Elevation about one Foot high; after it was well ſet and dry, they unſcrewed the Frame and took away its Sides; and the Arch ſtood of itſelf; they then pulled it about the Room from one End to the other, to ſee whether the Motion would any ways ſhatter the Work; but he found it remain firm and intire, and no ways damaged by the ſhake; afterwards he put on the Top of it as many Stones as it was poſſible to cover the Surface with, and this it bore without being in the leaſt affected, or ſuffering the leaſt Alteration by ſo great a Weight; at laſt they attempted to break it, by letting many great Stones fall upon it from on high, with a great Force. Theſe Stones indeed after many reiterated Blows did make ſome holes, but were far from deſtroying it abſolutely, and they found that it could not be deſtroyed but by Degrees and by Piece-Meals.

Another Perſon being curious to ſee the Solidity of theſe flat-Arches, made this Experiment: he conſtructed a little Flat-Arch in the Form of a Coach-Top, and after he had done he ordered from each of the four Sides a conſiderable Part to be cut away, and leave only that Part ſtanding that Butted againſt the Angles, the Arch now appeared like Elliptical Hoops, interſecting each other at the center

Center and ſupported only by its Angles, he then put a conſiderable Weight on the Interſection, and notwithſtanding theLoſs of ſo great a Part of the Arch, it bore it well and did not give in the leaſt.

I will now mention ſome Experiments of my own, which I think will remove all Doubts in this Matter. I conſtructed an Arch in the Form of a Coach-Top over a Room that was more than 24 Foot and half Square, and the Inſtant it was finiſhed loaded the Top of it with ſeventeen hundred fifty Bricks, each Brick weighing 25 Pounds. The whole Weight therefore laid on amounted to 43750 Pounds, which I left ſo ſtanding upon it for the ſpace of two Days, which greatly ſurpriſed the Builders andWorkmen of Rouſſillon, who had themſelves erected it; they all told me that I had put their Work at too ſevere a Trial, that the Ribs of the Arch were void and not filled up, that the Arch was loaded with a conſiderable Weight upon its Top only, but that if I would ſuffer the Ribs to be filled up I might put thereon what Weight I pleaſed, and they ſhould not fear its ſtanding. I ordered that the whole Weight ſhould be immediately taken of, to ſee if by getting rid of the Incumberance, the enſuing Lightneſs would have any Effect, or cauſe any Alteration in the Appearance of the Arch, but found none, it remaining as it did before.

I or-

I ordered another Arch, which I lately built, to be bored through in seven or eight different Places, and that the Holes should be made near one another with the Diameter of about six Inches; when this was done you might have walked upon the brink of these Holes without Danger, then we filled up the Holes, and the Arch remained as if nothing had been done.

But for a further Conviction, in a Room of 18 Foot wide and 28 Foot long, the Walls of which being two Foot thick and the Height 42 Foot, I built three of these Arches one upon another, and upon the last I erected my Bricked Roof; six Months after I ordered one of them to be bored, to see whether I could not contrive a Stair-Case, to go to the intermediate Room, between the Arches, this was effectually done, and I think it a clear Answer to those who object to the Solidity of these Arches, and say that they push against the Walls and that it is absolutely necessary for them to have a great thickness to Support them. All these Instances I say ought to convince them and wean them from a Notion they have falsely entertained. As to myself, they carry so clear an Evidence with them that I can well assert (provided the Walls are good and well built) their thickness signifies nothing, the thickness of the Walls cannot signifie much, because we see the thin

Parti-

Partition-Walls bear them, as I have often proved and experienced myſelf.

But ſtill, they may ſay that there are ſome of theſe Flat-Arches that have fallen in many Places; this I full well know, but then they have been built by unſkillfull Workmen, who very badly executed the Plan, and obſerved not proper Rules for their Conſtruction, or uſed bad Materials throughout the whole Work, but they cannot bring me an Inſtance where they have thrown down the Walls, or put them out of their Bevel. Indeed I have known ſome to have fallen by their having been built too flat, but they never puſhed out the Walls, only fell flat on the Floor, a certain Proof of their having no puſh as other Arches have; for the Plaiſter, when it is ſpread over the Work on all Sides, covers the Bricks of the Arch as in a Caſe, and the whole is one maſſive Cake without any Chaſms whatever. The one Side of the Arch butts not againſt the other, and ſo by counter-Acting ſupport each other, but the whole Arch is one entire ſolid Maſs and is contained in itſelf by its Particles, in the ſame Manner as a Flat Marble Table is, whereof the Middle Part is united as ſtrong as the other Parts by its natural Particles, and will not divide, if it be properly ſupported; in ſhort if the Conſtruction be judiciouſly managed the four Walls muſt be removed before the Arch will fall.

Thoſe

Thoſe who have tried, full well know the Strength and Force of Plaiſter, they will find what I have ſaid to be very true, and my Reaſoning juſt, for it is founded on a Multiplicity of Experiments. I hope I have given no Offence by making this little Digreſſion, and attempting to explain the Nature of theſe flat-Arches; I am very ſenſible of their Conſequence, and therefore was willing to publiſh all I knew of them, and ſet the Subject in the beſt Light I could.

First Cut.

I am now to deſcribe the Bricked-Roof. When the Arch that is to ſupport the Bricked-Roof is compleated, then they build thereon ſeveral Partition-Walls, about a Foot diſtant one from the other; theſe are to be erected with the ſame Inclination or Slant that you give to the Roof itſelf, for they are to be the under Supporters and to prop it up. * theſe Partition-Walls are to be diſcontinued in the Middle of the Arch, troughout the whole Building; ſo that a Paſſage will then be left, that you may go under the Roof as often as Occaſion requires.

Figure 1ſt { Denotes the Plan of the Arch.
A { The Gallery.
B { The Plan of the Partitions.

Figure 2d { The Section of the Plan in its Length.
A { Section of the Gallery in its Length.
B { Section of a Partition ſeen in Front.

Figure 3d { Section of the Plan in its Breadth.
A { Section of the Gallery in its Breadth.
B { Section of the Partition a Croſs.

* It muſt be noted that the Partition-Walls are to be built with two Bricks put Back-to-Back, inclining to the Heigth intended, and they muſt be cemented with Plaiſter; theſe Bricks are to be in Length fifteen Inches, in Breadth ten Inches, aud in Thickneſs two Inches; ſo that the Partition-Walls will be ſomething more than four Inches, becauſe of the intermediate Plaiſter the Brick-are cemented with.

When

When all the Partitions are erected, you are to cover the intermediate Spaces of the Partition-Walls with a double Tegument, by immediately laying a Bed of Bricks from the one Partition to the other. All theſe Bricks muſt be cemented with Plaiſter, as the Diſtance between one Partition-Wall from the other throughout the whole Work is one Foot, and as the Brick to be uſed is fifteen Inches Long, it of courſe muſt lie one Inch and an half on each Partition-Wall. This Tegument is deſcribed in Figure 2 and 3 by the Letters C. C and follows the ſame Slant or Inclination of the Partition-Walls, which ſupports it from C. to H Figure the 2d.

At the End of the Tegument C. C. there an Arch is to ſpring, to make a Covering to the Paſſage, as you ſee in Figure 2d. When the Arch is done, they go on with the Tegument on the Outſide of it from H to F; and to make the Work more ſubſtantial they make this Tegument double, by laying a ſecond Range of Bricks on the firſt, and in their Building particularly obſerve, that the Joints of the ſecond Bed of Bricks are never to interfere with the Joints of the firſt; this Tegument having been again cemented with Plaiſter.

As the little Arch or Covering Paſſage is of Elliptical Curvature, we are obliged on the

Top of it to make another little Arch, to run through the whole Length of the Paſſage, as you ſee in E conſtructed with hollow Tiles, which muſt form a Point, nearly Equal to the Acute Angle of the Roof, ſo that the Tegument at F, which you ſee on the outſide of the Arch, may be conſidered as the Point of the Baſe, whereon the remaining Work quite to the Ridge is to reſt. To avoid the Expence of the ſecond Work, you may build a Gothick Arch only; it will give a greater Heigth to the Paſſage, and it will have this Advantage, that People may walk there without ſtooping; the Roof indeed will riſe to a more acute Angle, and it is abſolutely neceſſary it ſhould do ſo, for Northern Countries, where ſo great Quantity of Snow falls. 1 is the Gutter. As the Leaden-Gutters with the Baluſtrades thereon are found to be very expenſive, all this may be rejected, and the Expence ſaved, by making at the Extremity of the Wall a Corniſh, ſo adapted to the Work, as to throw of the Water far from the Foundations of the Houſe, and to be built ſo as to coincide with the Angle of the Roof, and that the Tegument may be continued upon it, as you ſee in K ſecond Scheme The double Tegument being finiſhed, they cover it with hollow Tiles L, called in thoſe Countries Kennel-Tiles, which they lay in Mortar, made of Chalk and Sand, ſo that by theſe Means the whole Covering is made more ſolid, and all Crevices filled up, for ſome there will

will be that will eaſily be ſeen; but ſuppoſing there may be ſome Crevices by a Tiles breaking ſome where or other, the Water will then fall upon the Tegument, where finding a conſiderable Declivity it would then diſcharge itſelf, but ſuppoſing it to remain confined, it muſt be a great Length of Time before it can poſſibly ſap through the double Tegument. As theſe hollow Tiles are not common at Paris, you may uſe the flat Tiles, but thoſe muſt be laid on the Tegument in Plaiſter, and there will be no need of any laths at all.

The Entrance of the Paſſage within the Roof is at one Extremity, and at the other Extremity is placed the Window, which lightens the whole; but ſuppoſing a Window at the Extremity to be inconvenient and that a neighbouring Houſe ſhould exclude the Light you want in that Place, in that Caſe they make Dormer-Windows between the Partition-Walls which will lighten the Gallery much better.

Here follows the Conſtruction of my Bricked-Roof, which with Succeſs I finiſhed three years ago, in one of the Wings of my Houſe. The ſtrength of it remains firm and unaltered, notwithſtanding the great Weight it has bore for the Space of five Weeks, by the great Quantity of Snow falling upon it in *December* 1752, and in *January* 1753. and that in ſo great Abun-

dance, that the like has not been known in the Memory of Man, in thoſe Countries.

It is very eaſy to comprehend, by what I have already ſaid, and by the annexed Plans, the great Advantages of theſe Kind of Roofs, and of what Profit they will be not only for private Houſes but for Convents, for Churches, for Arſenals and for the Kings Magazines, throughout all the fortified Places of the Kingdom. The Roofs now uſed for all theſe Edifices are very chargeable, not only as to their Conſtruction merely, but as to the conſtant Repair they require, and which muſt at all Times be done. If per chance a Joiſt or Rafter is decayed, a Quantity of the Roof muſt be ripped and diſmantled, in order to make it good again; whereas in theſe Roofs of mine, if by length of time, the Work ſhould be any Ways worn, and the beating Rains make any Cavities in the Building, the Repair is immediately done, at the ſmall Expence of a little Plaiſter and a few Bricks.

If in the Time of a Siege a Bomb falls on ſuch a Roof, it can make but one Hole through the Bricked-Roof and flat-Arch, without doing any further Miſchief to each, and this may be forthwith repaired with little Trouble; whereas if it falls through the Roofs now in uſe, it not only deſtroys them, but all the Floors underneath making the greateſt Havock in all Parts of the Building,

Building : if red hot Bullets are caſt upon theſe Roofs, there can be no Communication of Fire in any Part of the Structure, and it will make its Way through, with no other Damage than what the Bomb did ; whereas in our preſent Roofs Fire may be communicated where ever Wood lies, and the whole Building ſuffer by it.

Thus then it appears that the Conſtruction of my Roof is the beſt poſſible, to prevent Damage by Bombs and red-hot Bullets to all Houſes and Buildings in general, and a proper Defence to any Neighbouring Edifices that might otherwiſe be conſumed. The other Advantages are not to be liable to Repairs ; Rats and Mice find no Shelter here ; Proviſions kept in Magazines thus built would not ſpoil or be deſtroyed by thoſe Creatures, they would always be kept cool, becauſe well defended from the Heat of Summer, by which great Damage and Loſs enſues, and the whole is often rendered unfit for Uſe.

The Window-ſaſhes and Doors of Houſes may be made in Iron-Work ; * by theſe Means

* There is a Manufacture lately eſtabliſhed at Eſſone, where all Kinds of Lock-ſmith works are carried on, and by the Contrivance of a Plate drawing-Iron compoſed of two Cilinders, the Work is much better than what is done in the common Method ; it is more perfect, more ſolid, cheaper, and done in much leſs Time. Among many other curious Works of this Manufacture you may ſee (at the Warehouſe in Bourdonnais-Street) a tranſome Window with its croſs-Bars, erected on a Pedeſtal, and as it is poliſhed and painted, there is no Body but would take it to be made of Wood. This Work has been done with great Skill and Propriety, for it appears very Light and the Moulds exceeding Delicate. For any thing in this way you may apply to Mr. *Durand* in Cordiers-Street near the Sorbonne it was to him that I gave the Idea of making Iron-Doors, whoſe Pannells will be of ſuch Iron-Plates which will make them as Light as other Doors are and may be ornamented as richly as you pleaſe.

nothing would fail and Repairs would be abſolutely avoided; all Riſk of Fire, of Vermin, of Filth and Naſtineſs are all excluded, your Appartments would all be free from Noiſe, be much cooler in Summer, and they would be warmer in Winter, becauſe the Heat would be reflected from the Walls when a Fire is made in the Rooms. Some Rooms of your beſt Appartments may be adorned with Freſco-Paintings, with Pannels of Plaiſter, or Stucco, reſembling the fineſt Carving of Wood, and in others, what Ornaments are neceſſary they may be gilded or painted, with ſuch Colours as you beſt approve of: inſtead of inlaid Floors of Wood, we might have a Pavement of Squared Stones, or Marble, or Tiles of the beſt Sort; and in Winter cover the whole with Carpets, and thus may an Houſe be built without any Wood at all. A great Expence of Furniture would by this Means be ſaved, and no Riſk run, and what Goods you have would laſt their Time properly, you would be accomodated with all Conveniences, and that in the greateſt Safety deſireable.

By their uſing Wood ſo generally in Buildings the Foreſts can no more ſupply you with a Quantity of it for your Men of War; whereas they would ſoon recover their Stock; and his Majeſty would ſoon have the Means to build his Ships without going to Strangers for that Purpoſe, if

theſe

theſe Bricked-Roofs were univerſally uſed for the Time to come.

There are in France ſome Buildings in this Form, without any Wood at all; the Chapels that ſurround the Dome of the Invalids are in this Faſhion, Stones laid one on the other, ſo as to project and ſupport each other, as Tiles do in common Roofs make the Roofs of theſe Chapels, and likewiſe form their Eves. On the Ridge of this Stone Roof there are other hollow Stones, like the common Ridge-Tiles, uſed in ordinary Buildings; all the Joints of the Stones anſwer exactly from Top to Bottom, and on this Joint they lay another ſecond Bed of Stones, by lapping the one over the other, even to the Ridge, which is terminated by a ſecond hollow Stone, which covers the Joints of all the other, that the Ridge is compoſed of; ſo that not one Joint appears in the whole Work; the Rain is carried of by the Spindles of the Stair-Caſes and runs under Ground.

Thus then if Houſes were to be built in the Manner of theſe Chapels they would be very expenſive; you muſt in this Caſe have very thick Walls to reſiſt the Thruſt of the Arches: You may indeed by diminiſhing the Thickneſs of the Walls diminiſh likewiſe the Thickneſs of the Arches; but then, Iron muſt be uſed to make good the Strength and guard your Building, and

more

more eſpecially if the Curvature of the Arches be low, great Quantity of Iron would be neceſſary for every Arch, and that would inhance the Coſt of the Building greatly, and at laſt Arches thus conſtructed would quickly be deſtroyed by Bombs, whereas there is no Iron in the flat-Arches or in Bricked-Roofs, and conſequently a Bomb falling on them would only make a Hole through of the ſame Magnitude of itſelf.

Beſides the Advantages before deſcribed, theſe Roofs may be conſtructed at a much leſs Expence than the common French-Roofs, as you may well judge by the following Detail.

A Bricked-Roof, for the Wing of an Houſe, ſuppoſing it to be 64 Foot long and 32 Foot broad, excluſive of Work, Coſts at Thoulouſe but 530 Livres, whereas a French-Roof with two Eves of the ſame Length and Breadth without Windows in it, will coſt at Paris, what with Wood-Work and what with Tiles, taking in Gutters, Lead-Work and Main-Beams, the Sum of 1395 Liv. 10 Sols and a * Flat-Ridge Roof of two Eves with its Collar-Beams, without Windows, of the ſame Length and Breadth, what with Joiner's Work and Tile-Work and its Collar-Beams would coſt, taking in every thing, the Sum of 2329 Liv. 15 Sols.

* It is a Roof whoſe acute Angle is cut at the Top and the flat-Part of it covered with Lead.

We

We may be assured that a Bricked-Roof would not cost more at Paris than in Languedoc, for though Brick be dearer, the Plaister is cheaper. Thus by making a just Comparison, you will find the Estimate pretty nearly equal to each other in Point of Charge, whether you build at Paris or in Languedoc.

The first Plate represents one of the flat-Arches, that I constructed at Thoulouse, to which I gave five Foot seven Inches Elevation from its Center, that is a little more than a third of the Breadth, of the Room. To take of from this too great Heigth, a Cornish was placed about ten Inches above the Spring of the Arch, and the Effect it produced was, that the Room appeared better and the Cove much more flat. This Plate represents likewise the Profil of my Bricked Roof, such as I myself built it.

The second Plate represents the Plan and Profile of a *Relievo*, that I made at Paris, in which I mended some Faults, that I remarked in my former. A bare Inspection of it is sufficient to shew how much the one is more preferable to the other, for in this the Arch rises no more than three Foot from its Center, *viz.* a very little more than a fifth of the Breadth of the Room, and a Cornish is placed above the Spring of the Arch, which is what I have done over all the Arches I have ever built.

I am

I am now to produce the Extract of the Certificate of the Royal Academy of Painting, of Architecture, and Sculpture at Thoulouſe, which confirms the truth of all that has been ſaid upon the Bricked-Roof.

Certificate of the Academy.

WE the underwritten Members of the Royal Academy of Painting, Architecture and Sculpture, deputed by the Order and Council of the ſaid Academy, on the 25th *March* 1753. to the Intent that we ſhould verifie and make known the Bricked-Roofs, conſtructed by the *Comte d'Eſpie* at his fine Houſe built in this City, and which he ſays are of his own Invention, and calls them Bricked-Roofs; after having been in his Houſe, and having conſidered, and with great Attention, examined theſe new Kind of Roofs, we find that their whole Conſtruction is Compoſed of Bricks and Plaiſter only, and that no Iron or Wood enters into the Compoſition; that they are the beſt Security againſt Fire, that the Matter of them is of that Strength and Solidity that they have not given in the Leaſt ſince the Time they have been built; we therefore have come to this Concluſion that they ought to be preferred on Account of theſe great Advantages to all the common Sort of Roofs, and that if all the Roofs of a City were thus built, a thouſand bad

bad Accidents would be avoided, and principally in fortified Towns, and in the Magazins of the King, in full Belief whereof we have under our Hands given the preſent Certificate to ſerve for thoſe whom it may concern. Done at Thouloufe the 22d of *Auguſt* 1753. Signed *Poiſſon*, Moderator; *Fabri*, the Principal Magiſtrate of the City and Commiſſary. *G. Pin*, Profeſſor and Commiſſary; *De Sevignac*, Profeſſor and Commiſſary; *d'Orbeſſan*, Secretary.

The following Objections may be made to the Author, that there is no Doubt of the Strength of theſe Bricked-Roofs, ſince it has been fully proved that they ſtood without giving for upwards of three Years paſt, but then they can only be executed in new Buildings, contrived purpoſely for theſe Roofs, becauſe you muſt have a Flat-Arch neceſſarily to ſupport them, and if you have a Mind to lay theſe Roofs on Houſes that are already built with the common Cielings and Floors, no Body would deſtroy the whole, merely to follow the Method here preſcribed. The Author has foreſeen this Objection, and allows the Reaſoning to be Juſt, and agrees that, at this Rate, People would be put at too great Expence if their Floors and Cielings were to be deſtroyed to make Way for theſe Kind of Roofs; but he ſays that if the Public approves of theſe Bricked-Roofs, he will hereafter in a Work more at large give a new Method to erect theſe Roofs

over

over old Buildings, whereby the old Roof only is to be removed, and then the Floors and Cielings may remain as they were at firſt built; this Change he apprehends will not come to any great Charge, ſince it is full well known that the Materials of a Roof are always ſaleable, and more eſpecially if it be a Flat-Ridge-Roof, where there is Lead, and that in ſuch Quantities as will pay the whole Coſt of a Bricked-Roof.

What an Advantage would it be for all Houſes in populous Cities to be built with Roofs of this Sort? for ſuppoſing a ſingle Houſe be fired, the Flames could only burn the Floors, Doors, Wainſcots, and Windows, and there it muſt neceſſarily ſtop, for the Bricked-Roof can never be affected; conſequently the Fire could make no further Progreſs, and all the other Houſes would remain ſafe and unhurt, which without Doubt would be of the greateſt Advantage to all Cities and Towns whatever; if a Chimney be on Fire, and the Flames guſh out of its Mouth with the greateſt Violence, we need have no Apprehenſions about it, provided the Roof be built according to this Form; but where there is a Roof with Wood in it, the leaſt Spark is not only capable of ſetting it on Fire, but likewiſe all other Houſes that are in the ſame Line of Building, may be, and are generally affected by it.

F I N I S.

APPRO-

APPROBATION.

BY the Order of the Chancellor, I have carefully peruſed a Treatiſe on the Conſtruction of Bricked-Roofs, with what is annexed thereto upon the Subject of Flat-Arches. I ſhould think it would be of the greateſt Inſtruction and Benefit to all thoſe who propoſe to engage in Works of this Sort. Done at Paris on the 20*th Fev.* 1754.

MONTCARVILLE,
Reader and Royal Profeſſor.

LET-

LETTER

From *Peter Wyche* Esqr. fellow of the *Royal Society* to the *Author*.

SIR,

THOSE who have employed their Time for the Benefit of Mankind in any useful Art, have in all Ages been deservedly applauded, and in my Opinion those seem to have the most Merit who by their Works have shewn that the saving of Mens Lives is the greatest Benefit to human Society; But in your Performance of Architecture, we see that not only the Lives of People are preserved, but their Property too. A Thought that must naturally attract the Attention of all who read your Work. The Method of building at Rousillon, tho' practiced for so many Centuries and that in no other Place of Europe, might still have lain unknown, had not your penetrating Genius made the Use of it manifest to the rest of the World, and that in so plain and easy a Manner that your Specimen ought to be a rule for all People in all Nations to go by: and what in this is most admirable is your own Invention of the *Comble Briquetté* or Bricked-Roof whereby both the Method of Building as well as the Roof itself is made more durable and less expensive than any Form yet contrived in Architecture. I have been

been so well satisfied with what you have wrote on this subject that I have presented your Book to a Gentleman * of great Fortune, an Encourager of all Arts and of those most especially where there is so great a Field for the Employment of industrious Poor. This Gentleman has lately been a Sufferer by the Accident of Fire, his House, Pictures, Books and other rare curiosities having been entirely consumed, to an immense Value; but tho' the Loss has been so great as that a Prince might regret, yet has he bore it with a Patience equal to the wisest Philosopher, and is now resolved to build again, but in such Manner as that his Edifice shall be no more liable to Accidents of this Sort. It is therefore to him that I have communicated your Specimen; for who can be more sensible of the Worth of it, than he who is desirous to avoid a Calamity by which he has already suffered so much? and for this Reason he must necessarily be the best Advocate for a Contrivance to secure not only himself, but the rest of the World from an Evil productive of the greatest Injuries to Society. But however curious and well described your method is, yet the building of an House whose Dimensions in Length are to be upwards of 23 *Toises* † and in Breadth nearly 12 *Toises* is not a Thing to be done by a written Discourse, but every Body in such Cases will have Workmen who have actually been engaged themselves in conf-

* *William Beckford*, Esqr. † A Toise is 6 Foot.

 tructing

tructing theſe Sort of Buildings for ſome Years; therefore, this Gentleman to do Honour to you as the Inventor, and more eſpecially that no Miſconceptions ſhould ariſe in the Theory Part, has deſired me to inform you that he is determined to build according to the Rules you deſcribe, being fully ſatisfied it will in every Reſpect Anſwer his Purpoſe. He deſires therefore to be informed whether you have ever built or ſeen a Flat-Arch of ſix *Toiſes* ſquare, what the loweſt Elevation of ſuch an Arch is from the firſt Riſe, and what Weight when formed it will carry, and what will break it: and likewiſe to know whether there be in Rouſſillon a Building of 12 *Toiſes* long and five *Toiſes* broad covered with ſuch flat-Arches and what the loweſt Elevation of ſuch an Arch is. He would be glad to be informed what would be the Price of Workmen to be brought here upon a Contract made with them by the Year, Allowance being granted for their Paſſage here, and return into their Countries on the Concluſion of the Building. The Matter of Expence he is not ſo ſollicitous about, as about the Abilities of the Perſons who are to be ſent him and therefore would have thoſe whom you have already employed, and whoſe ſkill for that Reaſon may be depended upon; for his Reliance is to be abſolutely on your Judgment. The great Objection we, on this Side of the Water, have to the whole Theory, is the Want of ſuch Plaiſter as you deſcribe; but probably you may have thought

on

on ſome other Material compounded of Lime and other things, which may be as Tenacious and as fit for the Arching as the Plaiſter is; if not, our only and laſt Refuge muſt be to have ſome Ship Loads of it from Rouſſillon itſelf; what the Price of this Plaiſter per Tun may be, delivered to the Ship, is required, and likewiſe what Quantity will do for to build a Flat-Arch of 6 *Toiſes* ſquare; for by knowing this we ſhall be able to compute how many Tuns of this Plaiſter will be neceſſary for the whole Edifice, and other purpoſes we ſhall want it for. Moreover as your Invention of the Bricked-Roof is ſo very ingenious, we are in particular deſirous of ſeeing that by a Model in Woodwork, done in Miniature, ſo that it may eaſily be taken in the Hand, and as eaſily be examined by the Eye: and then we ſhall be able to form it according to the preſent Taſte of building here; for our Houſes are not built in the Taſte of France, with High Roofs; becauſe our Country being in a High Latitude, is Subject to Tempeſtuous Winds, and that continually for a third Part of the Year. Laſtly, we deſire to know whether you have printed your greater Work which is mentioned in your Specimen; if it be publiſhed, we ſhould be glad of a Copy or two; and care will be taken that your Endeavours for the Good of Mankind ſhall be eſtabliſhed here with as good a Reputation as it is in the Parts where you live. The Gentleman has already fixed on his Plan, and propoſes to

Arch his lower Appartments with Brick and Mortar in the common Manner; for in your Specimen you tell us the plaiſtered Arches will not do wherever the Moiſture of the Ground influences, therefore he deſires, as he muſt proceed on his building now begun, that you would ſend me an Anſwer to the ſeveral above mentioned Articles, with ſuch Expedition as the Nature of the Caſe and your own Convenience will admit of, the ſooner the better. It is a Thing ſcarce credible in ſo philoſophical a Nation as England is, that their Method of building ſhould be ſo ſubject to Fire; ſcarce is there a Year paſſes but the Damage done by that Element thro' the Kingdom amounts to no leſs a Sum than 150000 Pounds, and therefore what Honour does not that Man deſerve who can for the future prevent Calamities of ſo dreadful a Nature? how many Lives, what property is this ſaving? And conſequently as the Attention of the whole Nation is upon this Work, ſo muſt the Praiſe, if well compleated, finally center in the Eſtabliſhment of your Character. The greateſt Care incumbent on you in this Matter is, to be accurate in providing us with the moſt able, moſt expert and moſt ſober Artiſts, who, aſſure yourſelf, will not want Encouragement ſuitable to their Merit and Induſtry: and then we may reſt ſatisfied that every thing elſe will be done to the utmoſt of our Wiſhes, I am

Your moſt humble Servant
PETER WYCHE

London
May 11th 1755.

P. S.

P. S. The Workmen required will be

1. The Conſtructor of the Arch Work
2. The Carpenter for the Centers
3. The Burner of the Plaiſter
4. The Inſpector of the whole work, and who can teach others while the Conſtructor is about his own Work.

The Models, for the making of Bricks in the manner deſcribed in your Book, ſhould be brought conſiſtent with their ſeveral Dimenſions.

Q. Whether, when all the Walls of the Houſe are built as high as they ought to be, it would not be adviſeable to build the upper Arch with the Bricked-Roof firſt; for by that Means the lower Arches may be built under Cover of it, and let the Weather be what it will the Workmen will be ſheltered — Q. If the Rooms on each Floor be of the ſame Dimenſions, it would not be a great Saving of Expence to have the Centers moveable, ſo that when the higheſt Arch is finiſhed by ſlipping the Centers, the ſame Centers will do for every ſucceſſive Floor — Q. Whether by fixing a ſmall *Ciſtern* on the Bricked-Roof, whether Water cannot be communicated to every Room in the Houſe — Q. Wheter by making a Flue conveniently in every ſolid Wall having a Communication with the outward Air, ſuch Quantity whether great or ſmall of Air may be let into every Room that may purge it without any In-

convenience from any ſmell occaſioned by the Effluvia of Victuals or any other whatſoever.

The Count of *Eſpic's* Anſwer to *Peter Wyche* Eſqr.

SIR,

YOUR Favour of the 10th Inſtant I duely received, and ſhould have anſwered it ſooner, had I been in Town when it came. What you have ſaid on this ſubject is a full Recompenſe to me for all the Labour and Trouble I have taken in this Affair, and could wiſh for an Opportunity of returning you my Thanks in Perſon in your own Country. But as this is not at preſent in my Power I ſhall endeavour to give you all the Satisfaction I am able, and anſwer what you deſire to know about my Specimen, that your friend may execute the Deſign he has of building his Houſe, and ſecure himſelf for the future from the Accidents of Fire by which he has lately been ſo great a ſufferer. You give me no Account of the Manner of building in England whether their Houſes are built with Stone or with Brick: and in fact, provided the Rules of Art be exactly obſerved, and the Walls be two Foot thick and the Materials have no Moiſture in them, this is the only Thing neceſſary, and it matters not whether they be of Stone or of Brick. In order to Frame your Building agreeable to my Plan, Your

Bricks

Bricks muſt be of three different Dimenſions; that is, Bricks of ten Inches long, five Inches broad, aud of one Inch thick for the Arches; Bricks of fifteen Inches long, ten broad, and two Inches thick for the Roofs; Bricks likewiſe for the Roof that are to be fifteen Inches long, four Inches broad, and two Inches thick; I know of no other Cement proper for theſe Works but Plaiſter, and I can not think the Charge would be much in point of Freight from France to England, ſince there is ſo great an Abundance of it near our Sea-Ports, as at Bourdeaux, Marſeilles, Bayone, and at Roüen; at which laſt Place I am told there are large Rocks of it, and may be had very cheap. It coſts me at Thoulouſe from ſix Pence to eight Pence a Sack, the Weight whereof is about eighty Pounds, but I would adviſe you to buy it from the Rock itſelf and burn it at the Time when you conſtruct your Arches; for then the Plaiſter will have more Fire in it, and conſequently will be more tenacious; whereas was you to have it in Powder the Work would be in Danger of Failing, as the force of the Plaiſter would be conſiderably diminiſhed. You may without any Difficulty build flat-Arches over Rooms whoſe Arches are thirty ſix Foot ſquare and more if required; conſequently you may do it over a Room of 72 Foot long and thirty broad, or even more if you have Occaſion for it; and as to the Elevation of theſe Arches you ſee in my Book, that a third of

the Breadth of the Room, if you build it after the Italian Manner, is the proper heigth ; a fifth of the Breadth if you would not have it rise so nigh as the Italian form, and an Eighth if you would have it of the least Elevation, some have given no more than a 9th or even a 10th Part of the Breadth of the Room for its Elevation, but I think it is hazarding too far. As to the Thickness of these Arches you must have seen in my Book, that it cannot exceed three Inches, that is the two Bricks laid flat on each other make two Inches, and the Plaister that is above them and under them will make nearly another Inch; now these three Inches will bear any Weight that can possibly be wanted for any Use whatever, as may clearly be seen in the Experiment I described of loading an Arch of 20 Foot square, whose Sides were not fixed up nor were they loaded, and consequently the Central Point bore all the Weight. You see in my Treatise that it is absolutely necessary the Walls be all built to their Height and remain so for six Months before you begin to build your Arches ; and that the uppermost Arch is to be first constructed, on which you are to build the bricked Roof, and then the other Arches downwards. As to the Centers they are only to guide the Workmen, they bear no Weight may be made at very little Cost, and it would be needless to use the Caution you mention. As to a large Cistern you vould have fixed on the Top of the Building, and thereby

thereby that every Room of the Houſe would be amply ſupplied with Water, that may be well done, provided it he fixed on an Arch made of Lime Mortar, for Moiſture is contrary to the Nature of Plaiſter. I very well approve of your Idea of contriving Pipes in the Walls themſelves to expell all bad ſmell; but I would have them only in Kitchens and other Offices, and they ſhould not be near one another, becauſe the Walls may be weakened by them. I think, Sir, I have now anſwered all the Paragraphs of your Letter, and if any Farther Doubts ariſe, be pleaſed to communicate them to me, and I ſhall with the utmoſt pleaſure endeavour to give you all the Satisfaction I am able to do. I am to ſet out for Paris in *July* next where I have already ſent the Workmen who built my Arches, the King of France having ordered me to make a Modell of my Bricked-Roof at the Military School; when this is done, I ſhall be able to ſend theſe very Men to you, and that will be about the begining of *April* next; as to their Wages, I give them half a Crown per Day, and find them Victuals and Lodgings, but they will probably require more to go out of the Kingdom, beſides an Allowance for their Journey backwards and forwards; you need have no French Carpenter; your own Carpenters will ſaw Deals according to their Directions and they will form the Centers themſelves and likewiſe burn the Plaiſter. As to an Inſpector of the Work, I will ſave your friend

friend that Expence, by giving the proper Directions myſelf to the Workmen that are to be ſent you; for which Reaſon be pleaſed to let me have your Plan of the Building with the Height of the Walls and the Profiles and upon viewing it, I ſhall determine where the Maſons are to leave Niches for the Arches to take their Riſe. As to the ſmall Modell you aſk of me, I ſhall get it done when I am at Paris. I wiſh Sir that what I have ſaid may be ſatisfactory, for it will be a great Pleaſure to me to be uſeful to your Nation, for which I have a particular Eſteem and Reſpect. I have the Honour to be

Your moſt humble Servant,
The Count of Espie

Thouloufe
27th *May* 1755.

The *Authors* Letter to Mr. *Dutens.*

Paris 17th *January* 1756.

SIR,

YOUR ſeveral Letters of the 1ſt and 8th of this Month I duely received, wherein I am informed of your Intentions of tranſlating my litte Book, a Compliment too great for me to paſs by, without expreſſing my Thanks to you on the Occaſion, and telling you how ſenſible I am of the Honour you do me, not doubting but by its paſſing thro' your Hands it

it will acquire a new Merit, and that the Publick will value the tranſlation more than the Original. In this Country every Body is with great prejudice ſet againſt new Inventions, let them be ever ſo well grounded in fact it matters not, their averſion is ſo great that they never give themſelves time to conſider them, and thus it is that by ſervilely following old Cuſtoms their Reaſon is led abſolutely by Caprice and ſometimes by Intereſt, and hence it is, that the great End propoſed of doing *Good to the Publick* is rendered null and is by them conſidered as no Argument at all. In a Word the ſyſtem I have publiſhed can never be thought a mere Project, but a fact actually exiſting, and has been examined into, as appears by the Building I conſtructed at Thouloufe, and which has now ſtood five or ſix Years without failing in any one Circumſtance whatever. I come now, Sir, to the Paragraph of your Letter wherein you put ſome Queſtions to me; and in Anſwer muſt inform you that the Plaiſter of Paris is much more tenacious than that of Languedoc or Rouſſillon, for which Reaſon the Workmen uſe a greater Quantity of Water to mix it in, and thereby bring it to ſuch a Temper as to make it the proper Cement they would have it to be; and beſides, it has another Advantage over the Rouſſillon Plaiſter; for it reſiſts Rain, whereas the other when expoſed to it will ſlack, and reduce itſelf to Powder.

Powder. As to the Height of the Arches for a Room of 24 Foot ſquare, if you follow the Italian faſhion it ought to be 8 feet, that is, a third of the Side; if you would not have it ſo great a Curve a fifth Part of the Side is another good Proportion; and if you would ſtill have a leſs Curvature, three Foot or an Eigth of the Breadth of the Room is uſed; ſuch an Arch tho' much more Flat than others has ſtill all the Solidity ſufficient. I know that ſeveral Arches of this Proportion have been conſtructed, but I have not followed it in my own Buildings. The Workmen at Rouſſillon allow one Foot of Curvature to every ſix feet of the Breadth of the Room; ſo that if your Room be 24 feet broad the Curvature ſhould be 4 feet; hence then it appears reaſonable that this Elevation will give the Arch all the Solidity neceſſary. The Curvature may be made to appear leſs by placing a Corniſh on the Arch at about 9 or 10 Inches above its Spring, and this will make the Cieling look more Flat, as you ſee it explained in my Book, and you may ſtill give a greater Grace to the Work by making a ſecound Corniſh. I intend to go to Thouloufe about the End of *February* next, where I ſhould be glad to ſee Mr. *Beckford* and make him ſenſible of what I have advanced in my Book. We have here a Compoſition called Spalm, it is a kind of Maſtick and withſtands Water, Worms &c. and is of ſo tenacious a

Nature

Nature that if you cement two Stones with it and drop them from a great Height, they will break in any Part ſooner than where the Cement is uſed. Send me your Direction and I will leave ſome of this Maſtick with a little Book for you. I beg you will return my Thanks to Mr. *Wyche* for his kind rememberance of me

I am with all the Eſteem poſſible,

SIR,

Your moſt obedient humble Servant.

D'ESPIE.

Extract of a Letter from *Willam Beckford* Eſq; to *Peter Wyche* Eſq;

Soho-Square May 12. 1755.

SIR,

I AM exceedingly obliged to you for intereſting yourſelf in ſo particular a Manner on my Behalf, the Public likewiſe will owe an Obligation, and a very great one to you if this Method of building ſhould ſucced as I verily believe it will.

I have peruſed your very Judicious Letter to the *Count of Eſpie* and any alteration would be improper and impertinent unleſs in that Part

Part where I think you ſeem to Entertain too favourable an Opinion of Myſelf, *&c.*

Give me leave to aſſure you that no Man has a higher Regard for your Friendſhip than,

SIR,

Your moſt obedient, and very humble Servant.

WILLIAM BECKFORD.

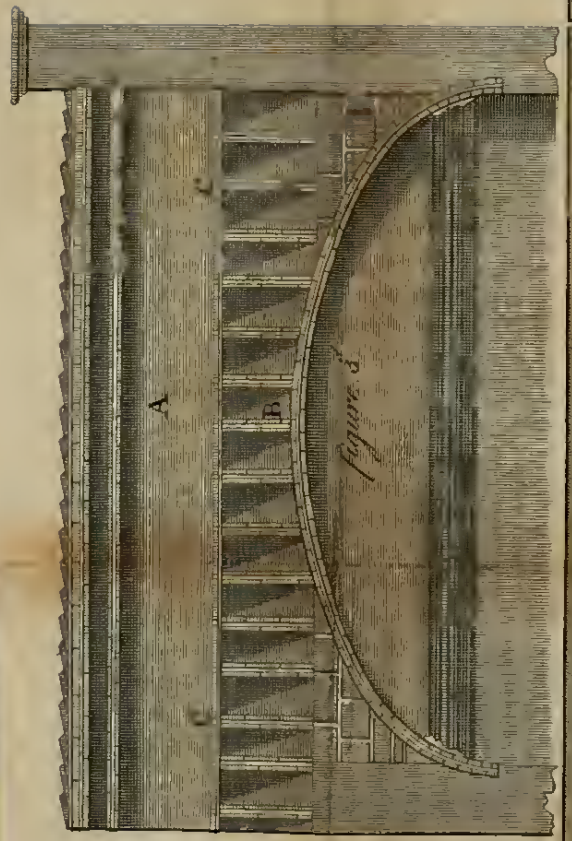


figure 3.

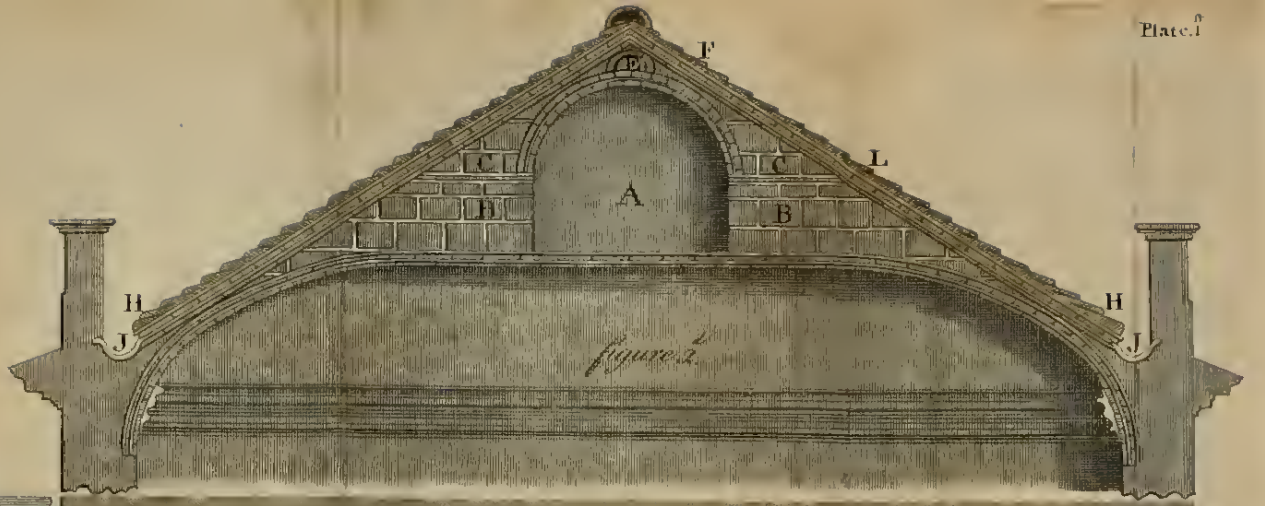


figure 2.

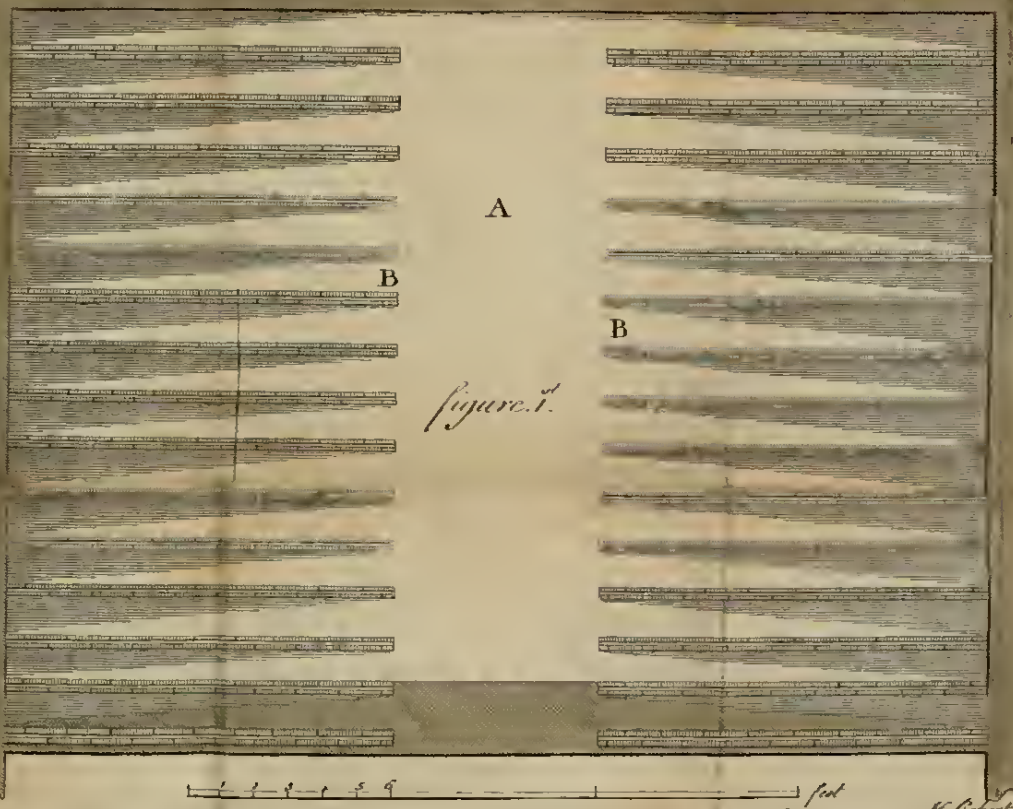
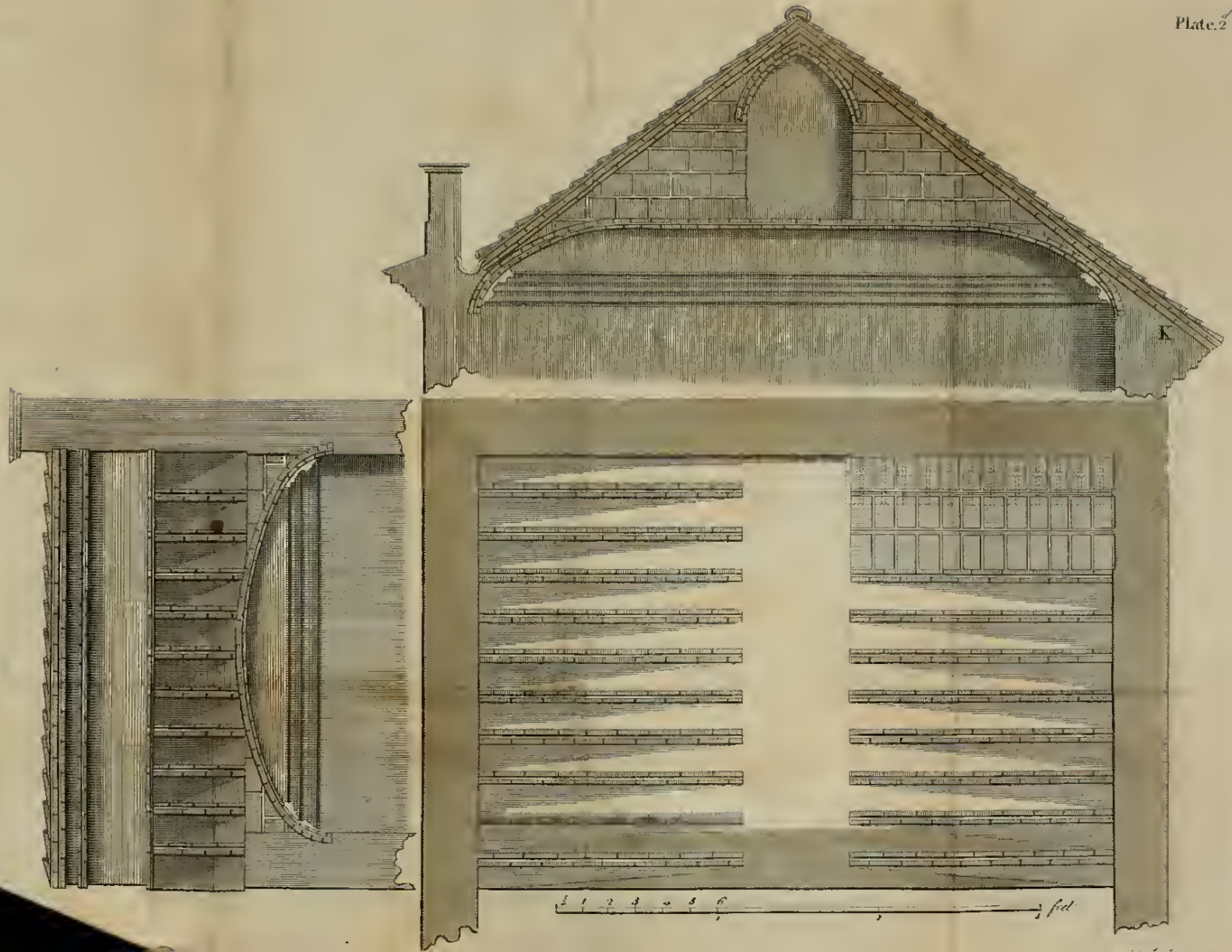


figure 1.

H. Roberts Sculp.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November 20, 1765.

To the NOBILITY and GENTRY, and to every Individual concerned in Building; but particularly to all Architects, Surveyors, Carpenters, Joyners, Bricklayers, Masons, Plaisterers, Stucco-workers, Papier Machée-makers, Ornament-modellers, Cabinet and Chair-makers, Upholsterers, Coach-makers, Painters, Plumbers, Stove-grate-makers, and Smiths, *&c.*

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